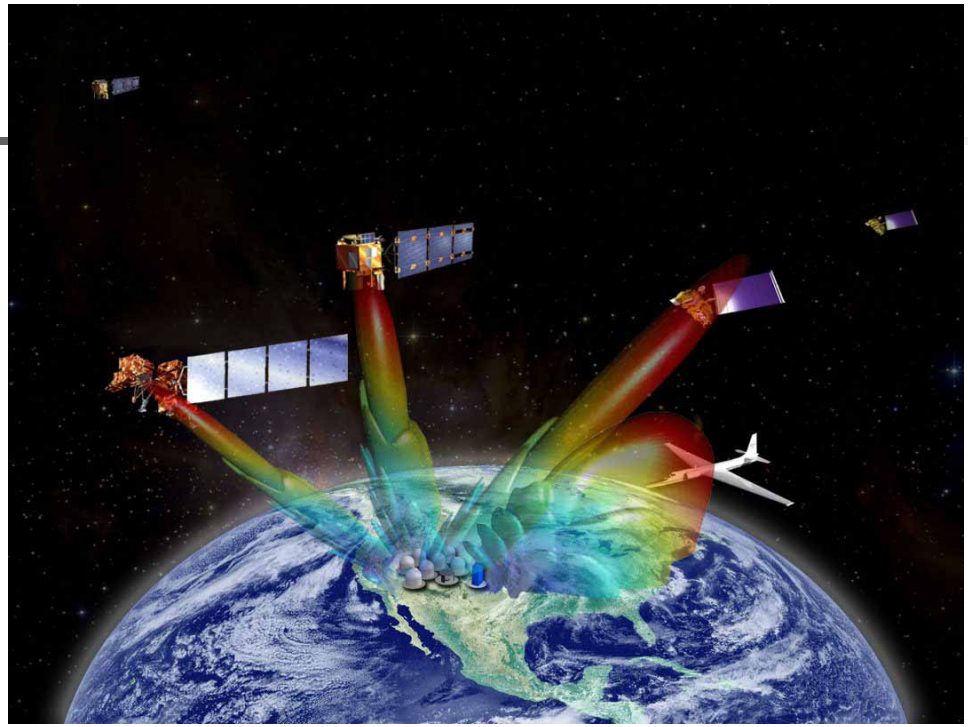


Sensor Web Experiments

Dan Mandl/584

ISD Workshop 1-24-05

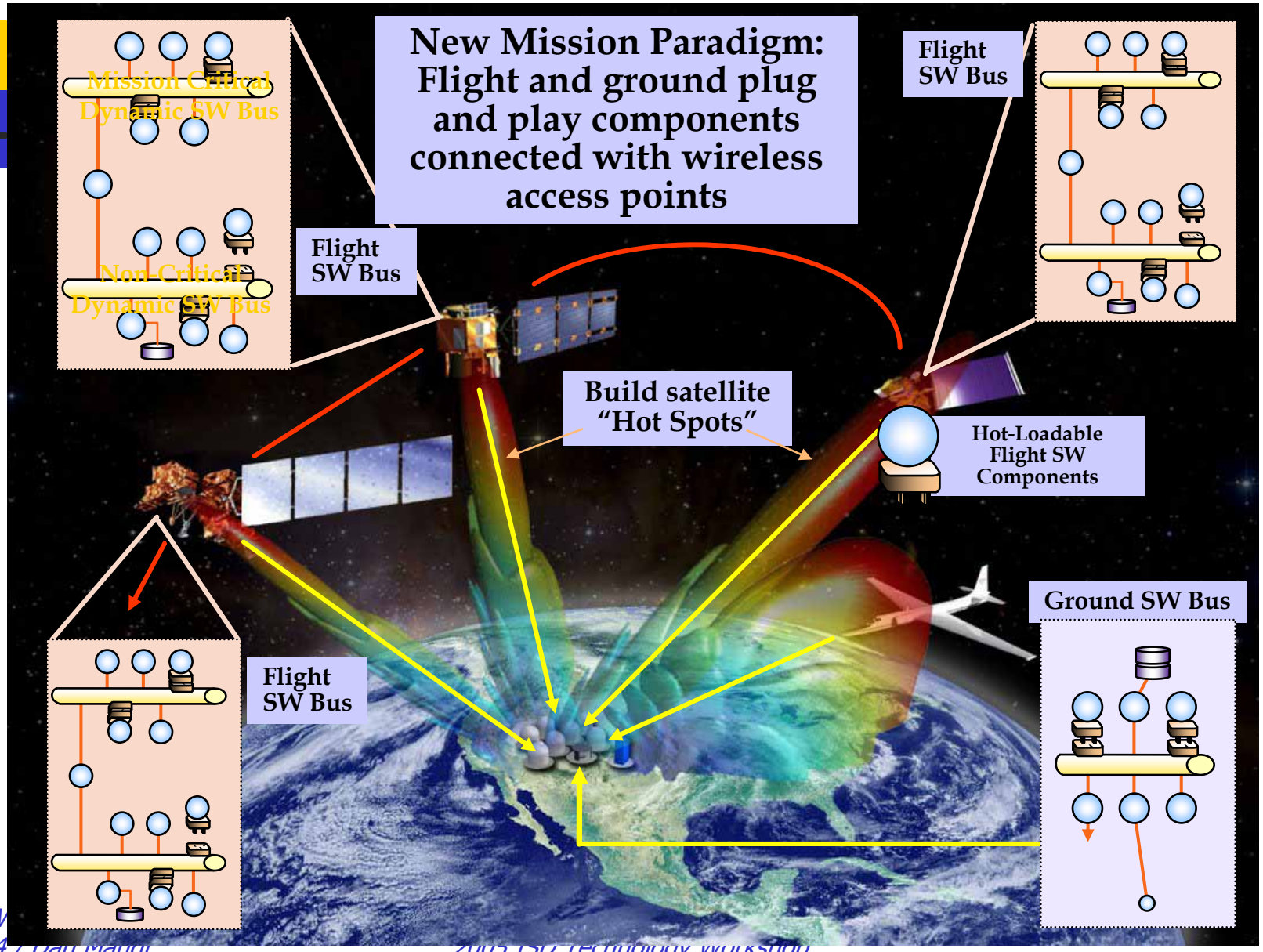
Goals, Objectives, Benefits

- Experiment with various triggering scenarios to create collaborative image collections between a set of ad hoc satellites
  - Create an "ad hoc" constellation via information systems
  - Facilitate future cost effective constellation by reusing existing assets in "ad hoc" constellations

Introduction

- Linked space and ground based instruments
  - Create interoperability between dissimilar assets to create a temporary virtual constellation – create Internet-like architecture
  - Image transient science events
  - Use various triggers
    - Events
    - Predictive models
- Fuse dissimilar data into composite image - different pixel sizes, spectral bands etc.
- Applications
  - Wild fires
    - Tracking, burn area rehabilitation, predicting fire path via fuel maps/weather
  - Volcanoes
  - Floods
  - Dust storms
  - Ice break up

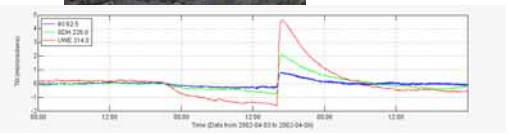
Vision to for Future Sensor Webs

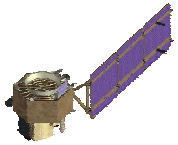


EO-1 Sensor Web Conducted Thus Far

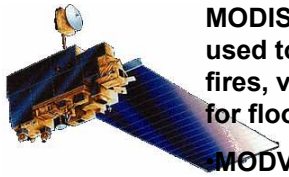
Volcano Tilt meters, Kilauea, Mauna Loa

•USGS Hawaii volcano observatory





EO-1 responds to triggers and has onboard triggers for snow, water, ice, land, thermal and clouds



MODIS (Terra and Aqua) used to detect hot spots for fires, volcanoes. Also, used for flood detection

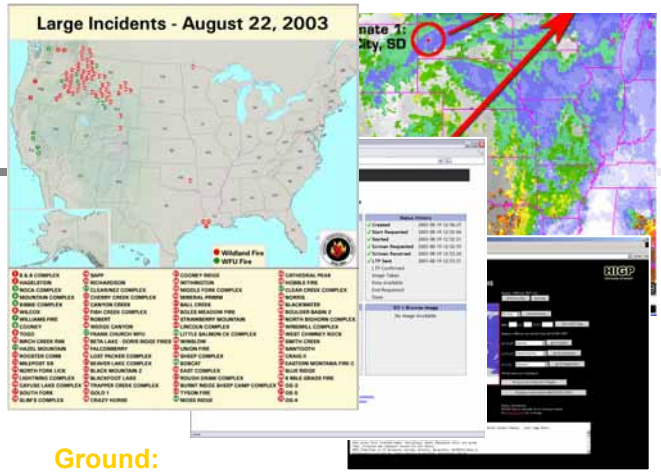
•MODVOC (Univ. of Hawaii)

•RapidFire(Univ. of Md.)

•Dartmouth Flood Observatory

GOES used for cloud screening near real-time

Triggers



Ground:

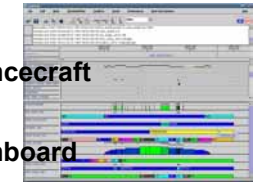
MOPSS: Mission Operations Planning and Scheduling System(GSFC)

SGM: Science Goal monitor(GSFC)

ASPEN: Planning & scheduling (JPL)

EPOS: Earth Phenomena Observing System - Cloud screening (Draper)

On-board:



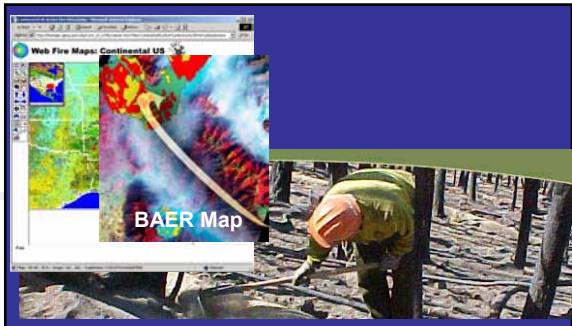
ASE: Autonomous Sciencecraft Experiment (JPL)

Livingstone (Ames) – Onboard diagnostic tool

Communication infrastructure:

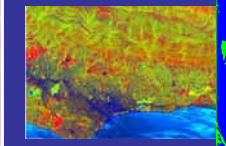
Cellular based architecture for spacecraft using phased array antennas (GSFC,GRC,Ga Tech, Univ. of Colorado)

Onboard & Ground Tools

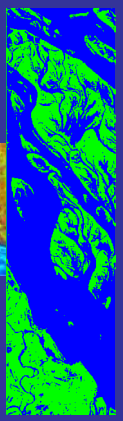


Fire rehabilitation

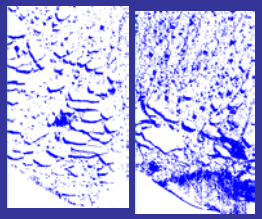
Volcano eruption detection & assessment



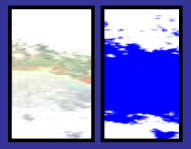
Fuel map to predict fire spread



Flood assessment

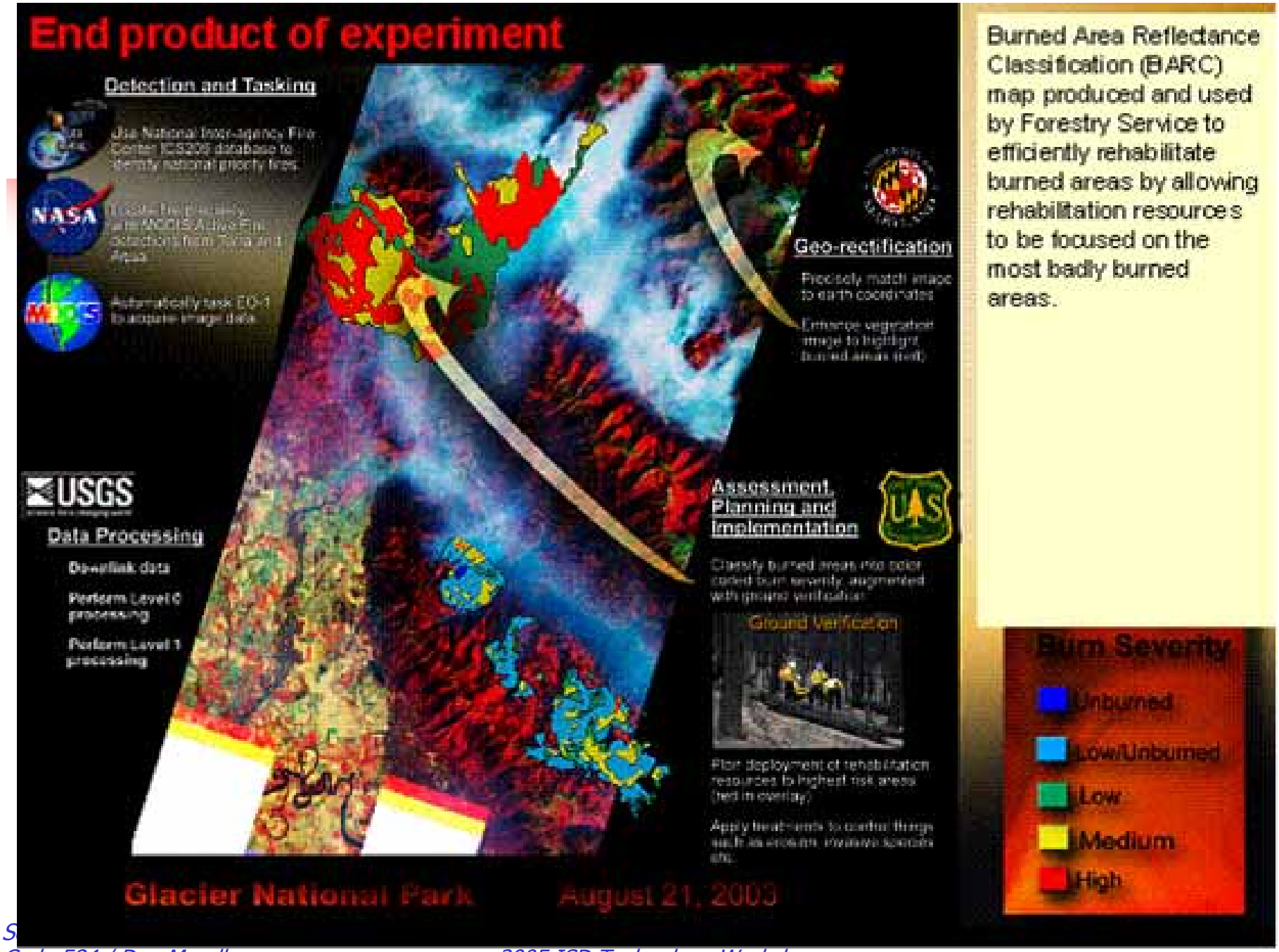


Ice breakup change detection



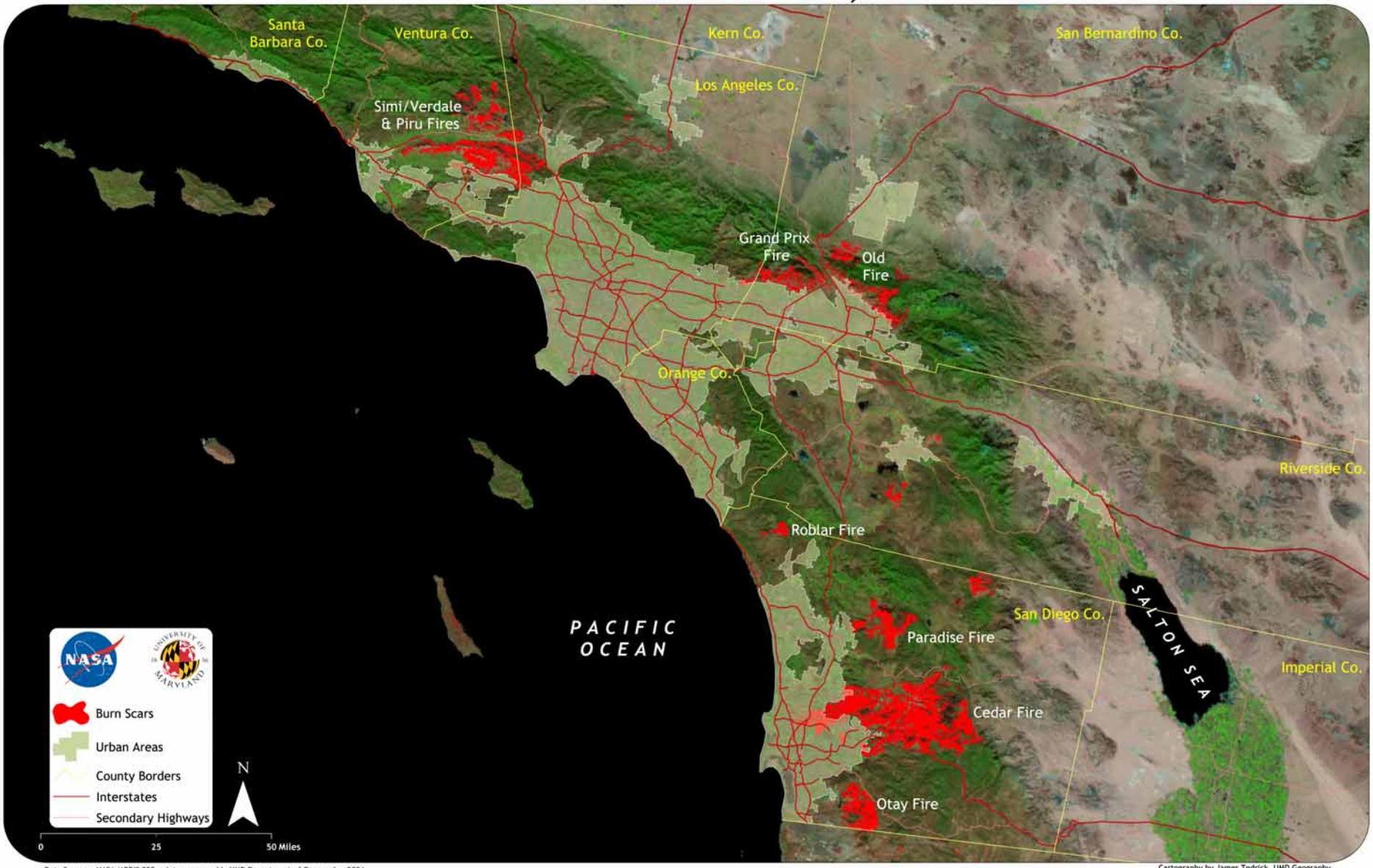
Cloud screening

Uses


End product of experiment
Detection and Tasking
Use National Inter-agency Fire Center ICS209 database to identify national priority fires.
Acquire the latest MODIS Active Fire detections from Terra and Aqua.
Automatically task EO-1 to acquire image data.
Geo-rectification
Precisely match image to earth coordinates
Enhance vegetation image to highlight burned areas (red)
USGS
Data Processing
Downlink data
Perform Level 0 processing
Perform Level 1 processing
Assessment, Planning and Implementation
Classify burned areas into color coded burn severity, augmented with ground verification
Ground Verification
Plan deployment of rehabilitation resources to highest risk areas (red in overlay)
Apply treatments to control things such as erosion, invasive species etc.
Glacier National Park
August 21, 2003
Burned Area Reflectance Classification (BARC) map produced and used by Forestry Service to efficiently rehabilitate burned areas by allowing rehabilitation resources to be focused on the most badly burned areas.
Burn Severity
Unburned
Low/Unburned
Low
Medium
High

Vegetative Cover Conversion

Burn Scars in Southern California, Winter 2003

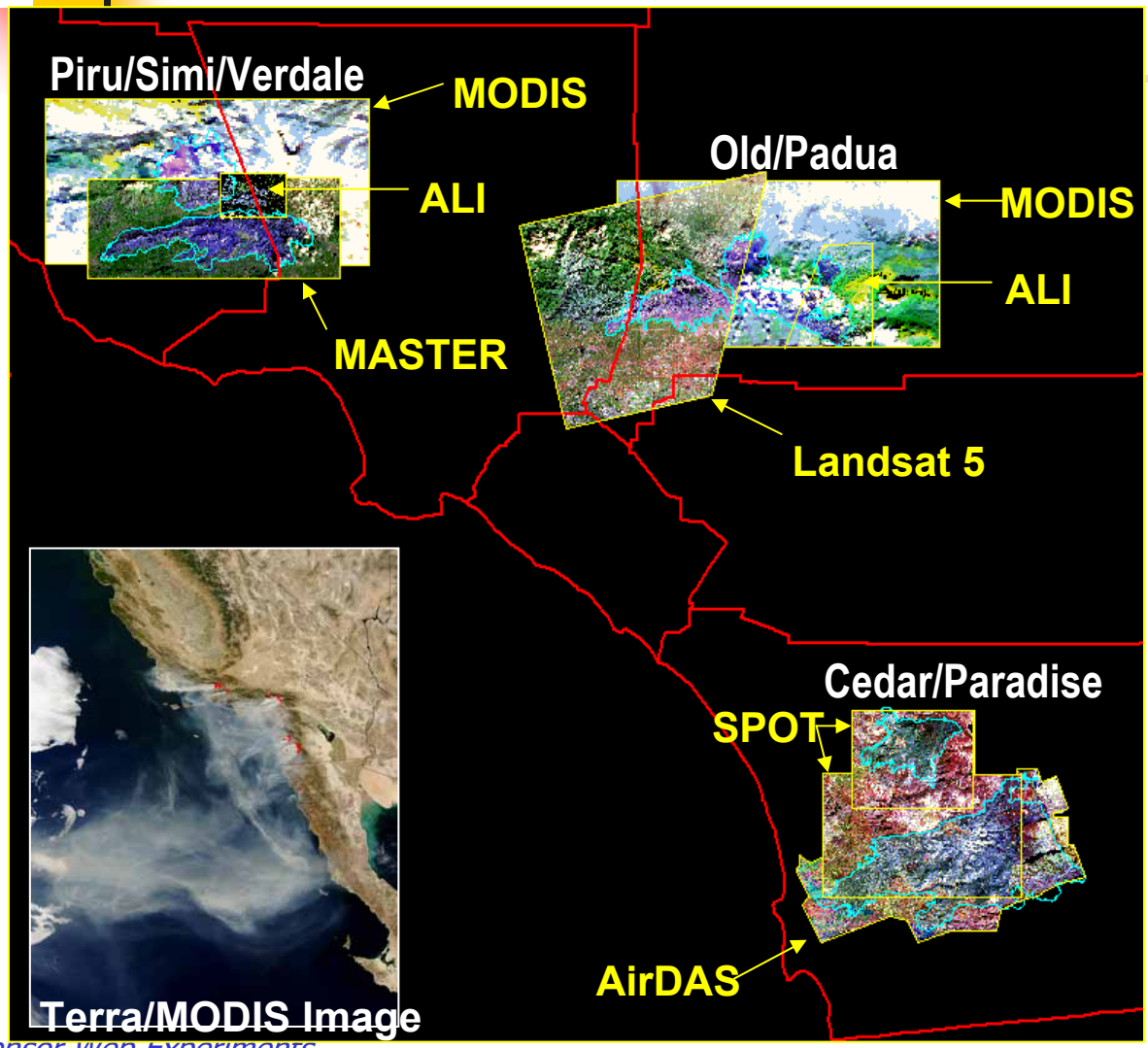


Data Sources: NASA MODIS 250m data processed byUMD Department of Geography, 2004
Environmental Research Systems Institute. ESRI Data and Maps 2003. Redlands, CA: Author.

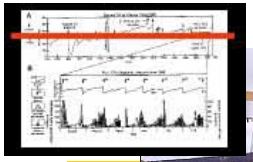
Cartography by James Tedrick, UMD Geography
2/5/2004

(4) Integrating Observations from Multiple Sources:

Southern California Wildfire Monitoring

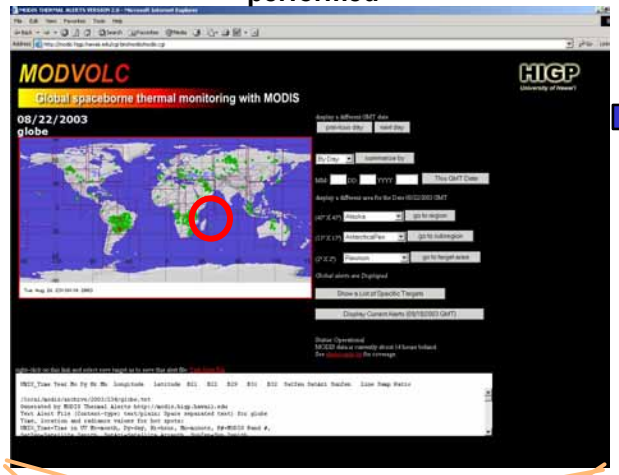


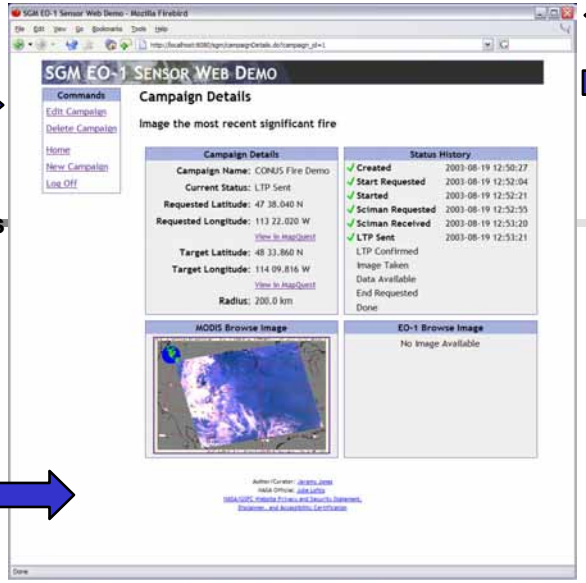
SensorWeb Demonstration Scenario with Volcanoes



1 Local ground networks monitor volcanoes (e.g tiltmeters, SO_2 in HVO,Hawaii)

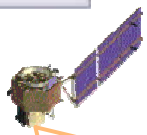
Global hot spots tracked by MODIS(MODVOLC, Univ. of Hawaii) & volcano screening algorithms performed





2 Load potential volcano onboard into CASPER targets for the next week

3
- •SGM monitors selected targets for volcanic activity
- •SGM selects active targets up to 4 hours before overflight
- •SGM resolves conflicting target choices based on near real-time GOES cloud cover data to make final picks



4 EO-1 acquires image and runs thermal detection science algorithms onboard with CASPER

5 Autonomous onboard thermal anomaly detection algorithm triggers repeat EO-1 image of same site at a later orbit (less than 8 hours)

6 Browse images generated onboard, downlinked via S-Band to ground station and then transmitted to Hawaii Volcano Observatory

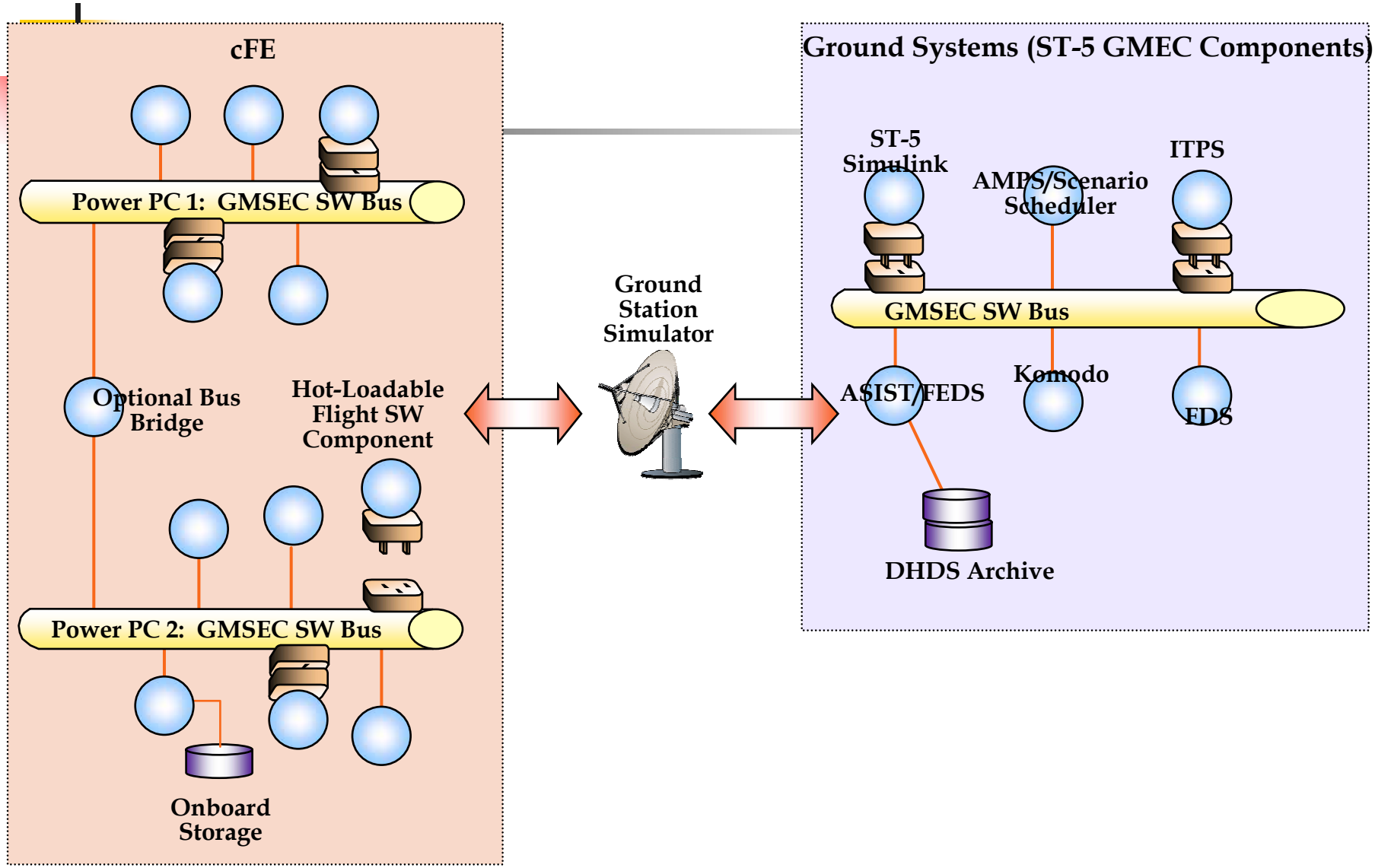
MODIS instrument on Terra and Aqua and AVHRR on NOAA 8, 9 & 11 used to detect hot spots

7 Target can then be used for other sensor web triggers such as UAVs

Build Autonomy Testbed to Extend Concepts

- cFE with software bus
  - Livingstone
  - ASE
  - Spacewire HW plug and play capability
- ST-5 GMSEC suite
- Ground Station simulator
- Demostrate hardware plug and play

Mission Autonomy Testbed



Future

- Experiments demonstrated that we can gain cost efficiency be designing future missions for reuse with different combinations of satellites
- Also demonstrated that by leveraging information technology, can create new science products to capture transient science events
- Should build autonomy testbed to facilitate integration of more of this type of capability into future missions